

## CLAIMS

What is claimed is:

1           1.     A method comprising:  
2     forming a trench and a via in a layer of dielectric material, the via having one end  
3           opening into the trench and an opposing end extending down to a conductor in an  
4           underlying layer;  
5     selectively depositing a layer of a sacrificial material over the dielectric material layer  
6           and over surfaces of the trench and via;  
7     depositing a layer of a conductive material over the sacrificial material layer and the  
8           conductor in the underlying layer;  
9     removing excess conductive material and excess sacrificial material from an upper  
10           surface of the dielectric material layer;  
11    depositing a layer of a porous dielectric material over the upper surface of the dielectric  
12           material layer and exposed portions of the conductive and sacrificial material  
13           layers; and  
14    removing the sacrificial material to form air gaps surrounding the conductive material  
15           within the trench and the via.

1           2.     The method of claim 1, wherein the sacrificial material layer comprises a  
2     polymer material.

1           3.       The method of claim 2, wherein the sacrificial material layer is deposited  
2 using a chemical growth process.

1           4.       The method of claim 2, wherein the sacrificial material layer is deposited  
2 using a photo induced-free radical polymerization process.

1           5.       The method of claim 1, wherein the conductive material comprises copper.

1           6.       The method of claim 1, wherein the excess conductive and sacrificial  
2 materials are removed from the upper surface of the dielectric material layer using a  
3 chemical-mechanical polishing (CMP) process.

1           7.       The method of claim 1, wherein the porous dielectric material comprises a  
2 silica based material, a silicon nitride based material, a silicon carbide based material, an  
3 amorphous carbon based material, or an organic film.

1           8.       The method of claim 1, wherein removing the sacrificial material  
2 comprises:  
3 thermally decomposing the sacrificial material layer into one or more residue materials;  
4           and  
5 performing a rinse process to remove the residue materials through the porous dielectric  
6           layer.

1           9.       The method of claim 8, wherein thermal decomposition is performed at a  
2   temperature up to approximately 450 °C.

1           10.      The method of claim 8, wherein the rinse process is performed using a  
2   supercritical CO<sub>2</sub> agent.

1           11.      The method of claim 1, wherein the air gaps each have a thickness of  
2   between 5 nm and 15 nm.

1           12.      The method of claim 1, wherein the underlying layer comprises another  
2   layer of dielectric material.

1           13.      The method of claim 1, wherein the underlying layer comprises a  
2   semiconductor wafer.

1           14.    A device comprising:  
2    an integrated circuit die; and  
3    an interconnect structure disposed over a surface of the die, the interconnect structure  
4           including  
5                at least a first dielectric layer disposed over the die surface,  
6                a number of conductors disposed in the first dielectric layer, at least some  
7                   of the conductors in electrical communication with conductors of  
8                   the die,  
9                an air gap surrounding at least a portion of each conductor in the first  
10               dielectric layer, and  
11               a layer of porous dielectric material disposed over at least a portion of the  
12               first dielectric layer.

1           15.    The device of claim 14, wherein the electrical communication between the  
2    conductors in the first dielectric layer and the conductors in the die is formed by a  
3    number of conductive vias, at least a portion of each conductive via surrounded by an air  
4    gap.

1           16.     The device of claim 14, wherein the interconnect structure further  
2 comprises:  
3 a second dielectric layer disposed over the porous dielectric layer;  
4 a number of conductors disposed in the second dielectric layer, at least some of the  
5 conductors in electrical communication with conductors in the first dielectric  
6 layer; and  
7 an air gap surrounding at least a portion of each conductor in the second dielectric layer.

1           17.     The device of claim 16, further comprising another layer of the porous  
2 dielectric material disposed over at least a portion of the second dielectric layer.

1           18.     The device of claim 14, wherein the conductors in the first dielectric layer  
2 comprise copper.

1           19.     The device of claim 14, wherein the porous dielectric material comprises a  
2 silica based material, a silicon nitride based material, a silicon carbide based material, an  
3 amorphous carbon based material, or an organic film.

1           20.     The device of claim 14, wherein the air gaps each have a thickness of  
2 between 5 nm and 15 nm.

1           21.    A system comprising:  
2    a memory; and  
3    a processing device coupled with the memory, the processing device including an  
4           integrated circuit die and an interconnect structure disposed over a surface of the  
5           die, the interconnect structure including  
6                   at least a first dielectric layer disposed over the die surface,  
7                   a number of conductors disposed in the first dielectric layer, at least some  
8                   of the conductors in electrical communication with conductors of  
9                   the die,  
10           an air gap surrounding at least a portion of each conductor in the first  
11           dielectric layer, and  
12           a layer of porous dielectric material disposed over at least a portion of the  
13           first dielectric layer.

1           22.    The system of claim 21, wherein the electrical communication between  
2    the conductors in the first dielectric layer and the conductors in the die is formed by a  
3    number of conductive vias, at least a portion of each conductive via surrounded by an air  
4    gap.

1           23.     The system of claim 21, wherein the interconnect structure further  
2 comprises:  
3 a second dielectric layer disposed over the porous dielectric layer;  
4 a number of conductors disposed in the second dielectric layer, at least some of the  
5 conductors in electrical communication with conductors in the first dielectric  
6 layer; and  
7 an air gap surrounding at least a portion of each conductor in the second dielectric layer.

1           24.     The system of claim 23, further comprising another layer of the porous  
2 dielectric material disposed over at least a portion of the second dielectric layer.

1           25.     The system of claim 21, wherein the conductors in the first dielectric layer  
2 comprise copper.

1           26.     The system of claim 21, wherein the porous dielectric material comprises  
2 a silica based material, a silicon nitride based material, a silicon carbide based material,  
3 an amorphous carbon based material, or an organic film.

1           27.     The system of claim 21, wherein the air gaps each have a thickness of  
2 between 5 nm and 15 nm.

1           28.     A method comprising:  
2     forming a trench and a via in a layer of dielectric material, the via having one end  
3           opening into the trench and an opposing end extending down to a conductor in an  
4           underlying layer;  
5     depositing a layer of a sacrificial material over the dielectric material layer and over  
6           surfaces of the trench and via;  
7     etching the sacrificial material layer to remove at least a portion of the sacrificial material  
8           layer overlying the conductor in the underlying layer;  
9     depositing a layer of a conductive material over the sacrificial material layer and the  
10           conductor in the underlying layer;  
11    removing excess conductive material and excess sacrificial material from an upper  
12           surface of the dielectric material layer;  
13    depositing a layer of a porous dielectric material over the upper surface of the dielectric  
14           material layer and exposed portions of the conductive and sacrificial material  
15           layers; and  
16    removing the sacrificial material to form air gaps surrounding the conductive material  
17           within the trench and the via.

1           29.     The method of claim 28, wherein the sacrificial material layer comprises a  
2     polymer material.



1           30.     The method of claim 28, wherein the conductive material comprises  
2 copper.

1           31.     The method of claim 28, wherein the porous dielectric material comprises  
2 a silica based material, a silicon nitride based material, a silicon carbide based material,  
3 an amorphous carbon based material, or an organic film.

1           32.     The method of claim 28, wherein removing the sacrificial material  
2 comprises:  
3 thermally decomposing the sacrificial material layer into one or more residue materials;  
4 and  
5 performing a rinse process to remove the residue materials through the porous dielectric  
6 layer.

1           33.     The method of claim 28, etching the sacrificial material layer to remove at  
2 least a portion of the sacrificial material layer overlying the conductor in the underlying  
3 layer comprises performing an anisotropic etch process.